Suisun Marsh Vegetation Mapping
Change Detection 2000

A Report to the California Department of Water Resources

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Introduction

Digital mapping technologies hold great promise for assessing and tracking change in vegetation patterns over large-scale landscapes. Change detection was conducted for Suisun Marsh, Solano County one year after the initial aerial photo interpretation, described in Vegetation Mapping of Suisun Marsh, Solano County – A Report to the California Department of Water Resources (Keeler-Wolf et al. 2000). The goals of the change analysis were to define significant change for vegetation in the Suisun Marsh ecosystem, quantify and spatially identify such changes, improve map accuracy, and make recommendations for future revisions of the map to best support management efforts for endangered species habitat, waterfowl, and other wildlife.

Methodology

The 1999 vegetation polygons, derived from aerial photographs flown June 16, 1999, were printed from ArcView onto mylar at a scale of 1:9600 to match the aerial photography. The unique number and vegetation code were also printed on each polygon. The mylar sheets were compared with the 2000 aerial diapositives (flown July 5, 2000) on a light table. Contingent with the original methodology, every other photo was examined. Please refer to the full report for details on methodology and classification.

The change information recorded on the mylar sheets was later transferred to an ArcView shapefile. The 1999 polygon coverage (suisun_veg99_attr2.shp) was copied and renamed (suisun_veg00_attr2.shp). This new file was edited by using the appropriate scanned 2000 aerial photograph as a backdrop in ArcView.

A database was established in Microsoft Access to record which polygons were interpreted to have changed. This database (change detection.mdb) is included in the Suisun Marsh Vegetation Mapping 1999 2nd Ed - Change Detection 2000 CD. The following information was recorded:

- **Unique_id** : the exclusive polygon identifier. [Note: this unique identifier does not correlate to the polygon numbers found in the original attribute database (Attributes_dec19.mdb). To generate the final map products, adjacent polygons with identical attributes were merged into single polygons to streamline the data set. The entire coverage was renumbered; these new numbers are used here and are consistent with the Poly_# field in the suisun_veg99_attr2 file.]

- **veg_code_99** : vegetation code based on 1999 aerial photo interpretation; “000” assigned to newly created polygons.

- **veg_code_00** : vegetation code based on 2000 aerial photo interpretation.

- **poly_size** : polygon size class; sm = <1 acre; md = 1-5 acres; lg = >5 acres.

- **change_class** : percent change in acreage for the polygon; 0 = none; 1 = 5-10%; 2 = 10-20%; 3 = >20%

- **notes** : “change” indicates a true vegetation change; “mislabel” indicates a map update.

Definition of Change

The following changes were considered significant and consistently interpretable, and were updated:

- A greater than 20% change in acreage of an exiting small polygon (< 0.5-1 acre)
- A greater than 10% change in acreage of a mid-sized polygon (1-5 acres)
- A greater than 5% change in a large polygon (>5 acres)
- A type conversion of a vegetation polygon dominated by perennial species. Type conversion as defined here, occurs when a previously mapped vegetation type dominated by perennial species has changed based on the decision rules set forth in the vegetation mapping unit key defined in the Suisun Marsh Vegetation Mapping Report (Table 5), or when an annual species dominated vegetation type is converted to a perennial vegetation type.
- A persistent physical change has altered any vegetation polygon and partially or entirely replaced it with a non-vegetated area (non-vegetated areas include buildings, dredged ditches, new levees, roads, or other human engineered structures).
- A change in management style, which includes a conversion or restoration from an actively managed situation (annual burning, disking, plowing, flooding, or other management practice which annually disturbs the vegetation) to a passively or non-managed situation.

The following changes were considered non-significant and/or unreliably interpretable and were not assessed:

- Annual to annual type conversion were not considered because of the vagaries of climate on annual vegetation. **Table 1** lists these excluded types.
- Polygons that are regularly heavily managed by annual burning, disking, flooding, or other means were not considered. These changes, unless they show some direction (e.g., from passive management to active, or vice versa), are considered regular management perturbations and maintain the same general vegetation pattern through regular disturbance.

Definition of Mislabel

Improving map accuracy was also a goal of this change analysis. The careful scrutiny of the entire study area provided opportunity to identify and correct errors.

Mislabel indicates one of the following occurred in the original attribution process:

- A keystroke error
- A misinterpretation of vegetation signature

Or

- A more precise vegetation label was assigned based on the 2000 aerial photography. For example, a polygon labeled 101 Tall Wetland Graminoid in 1999 was further interpreted as 123 Typha (generic).

Table 1 – List of Annual Type Changes Excluded From Assessment

The following is a list of annual dominated vegetation types not assessed if one changed to another. Please refer to the full report for identification and discussion of these types.

142 Distichlis/Annual Grasses	312 Atriplex/Distichlis
153 Distichlis/Cotula	315 Atriplex/S. maritimus
155 Crypsis schoenoides	315 Atriplex/Sesuvium
218 Lolium (generic)	329 Polygonum-Xanthium-Echinochloa
220 Lolium/Lepidium	336 Rumex (generic)
222 Lolium/Rumex	337 Atriplex/Annual Grasses
225 Cultivated Annual Graminoid	339 Atriplex triangularis (generic)
227 Annual Grasses/Weeds	342 Cotula coronopifolia
230 Short Upland Graminoids	357 Sesuvium verrucosum*
231 Annual Grasses (generic)	358 Sesuvium/Distichlis*
232 Bromus ssp/Hordeum	359 Sesuvium/Lolium*
234 Hordeum/Lolium	405 Raphanus sativus (generic)
235 Vulpia/Euthamia	406 Brassica nigra
238 Polypogon monspeliensis (generic)	413 Centaurea (generic)
311 Atriplex triangularis	

* *Sesuvium verrucosum* is a perennial species, however common management styles in Suisun Marsh result in an annual life cycle.

Limitations of 2000 Photography

The 2000 photo set for the Suisun Marsh were diminished in quality compared with the 1999 photo set in three ways: hue, focus, and cloud shadow. It is possible that some changes were missed due to these limitations.

A small number of photos were out of focus and of no utility, however adjacent photos were substituted. Cloud shadow on the southern tip of Dutton Island, Freeman Island, and Snag Island prohibited interpretation of vegetation type, although general vegetation patterns could be discerned.

Finally, the darkness of the entire photo set greatly limited its utility. Generally, a three inch diameter area in the center of each photo was of similar quality and hue to the 1999 photos with the remaining outer perimeter much darkened, tending toward black. Because of the flat aspect of Suisun Marsh and high incidence of active management, color and texture are the two most important features for photo interpretation of vegetation. The darkened photos made interpretation of vegetation signatures very difficult over much of each photograph.

Additionally, the 2000 photos were taken July 5, twenty days later than the 1999 photo set. Generally, the vegetation exhibited an advanced phenology, which added uncertainty to its interpretation. Conversely, some annual species were easier to interpret with the later photography, such as the *Polygonum-Xanthium-Echinochloa* type.

Results and Recommendations

The complete list of polygons modified in the change detection process is presented in **Appendix I**. The appendix is broken into two sections: (1) Change Polygons and (2) Mislabel Polygons with acreage totals at the end of each section. **Figure 1** shows the spatial distribution of this information. **Table 2** summarizes the results by vegetation type and includes the difference in acreage and polygon number between 1999 and 2000. **Table 3** is sorted by percent change in acreage and includes a brief qualitative description of the main causes of the acreage difference between 1999 and 2000. **Table 4** lists the vegetation types with no change.

Table 4 – List of Vegetation Types With No Identified Change

The following is a list of vegetation types with no significant change detected between June 16, 1999 and July 5, 2000. Refer to the Methodology section for more details.

002 Fallow Disced Field	238 Polypogon monspeliensis (generic)
003 Parking Lot	300 Wetland Herbs
008 Railroad Track	301 Tall Wetland Herbs
010 Trail	315 Atriplex/S. maritimus
012 Freshwater Drainage	316 Atriplex/Sesuvium
013 Water Treatment Pond	317 Frankenia/Agrostis
104 Phragmites/Scirpus	318 Frankenia/Distichlis
105 Phragmites/Xanthium	321 Grindelia stricta var stricta
112 Scirpus americanus/Potentilla	336 Rumex (generic)
114 Scirpus americanus (generic)	338 Potentilla anserina (generic)
121 Typha angustifolia/S. americanus	340 Short Wetland Herbs
125 Typha angustifolia (dead stalks)	342 Cotula coronopifolia
127 Scirpus americanus/Lepidium	350 Salicornia/Crypsis
133 Juncus balticus/Conium	359 Sesuvium/Lolium
134 Juncus balticus/Lepidium	360 Spergularia/Cotula
135 Juncus balticus/Potentilla	371 Potamogeton pectinatus
139 Scirpus maritimus/Sesuvium	405 Raphanus sativus (generic)
145 Distichlis/Juncus	406 Brassica nigra (generic)
153 Distichlis/Cotula	410 Medium Upland Herbs
155 Crypsis schoenoides	413 Centaurea (generic)
161 Cynodon dactylon	421 Carpobrotus edulis
202 Cortaderia selloana	502 Salix exigua
210 Medium Upland Graminoids	514 Atriplex lentiformis (generic)
215 Leymus (generic)	601 Medium Upland Shrubs
218 Lolium (generic)	603 Baccharis/Annual Grasses
220 Lolium/Lepidium	606 Rubus discolor
222 Lolium/Rumex	700 Willow Trees
223 Phalaris aquatica	702 Salix laevigata/S. lasiolepis
225 Cultivated Annual Graminoid	705 Salix lasiolepis/Quercus agrifolia
228 Agrostis avenacea	800 Eucalyptus
230 Short Upland Graminoids	901 Quercus agrifolia
232 Bromus spp/Hordeum	903 Quercus lobata
234 Hordeum/Lolium	910 Landscape Trees
235 Vulpia/Euthamia	911 Ailanthus altissima

There are 250 polygons included in the change detection analysis, eighty-three, or 33%, of these map updates (mislabels). There are 167 polygons (0.54% of polygons in study area) identified as having changed between June 16, 1999 and July 5, 2000. These total 514.69 acres or 74-hundreths of a percent (0.74%) of the 69,322 acres mapped in this project. The average percent change in acreage for the 55 vegetative and 8 non-vegetative types assessed is 0.02% with 0.75% the maximum gain (Medium Wetland Graminoids), and –0.60% the maximum loss (Oaks). The minimum change is 0.0007% (*Lepidium/Distichlis* and Slough).

The spatial distribution of both Change and Mislabel polygons is shown in **Figure 1**. Overall, the Change polygons are spread evenly throughout the study area, although only seven occur in tidal wetlands, totaling 12 acres. Approximately seven acres are due to change – increases in *Phragmites australis* (along slough edges), *Lepidium latifolium*, *Typha sp*. and *Scirpus californicus/S. acutus*. Twenty-five, or 15%, of the 167 Change polygons occur on Chipps and Van Sickle Islands, mostly due to increases in *Distichlis spicata* and *Scirpus maritimus*. *Scirpus californicus/S. acutus, Typha sp.* and *Phragmites australis* increased, as well.

The greatest change in actual acreage is a 143 acre loss of Annual Grasses primarily due to conversion to structures, urban areas and bare ground, and to the invasion of *Salicornia* and *Distichlis* types. Mislabels accounted for 58 of these acres (40%). *Scirpus maritimus* has the greatest increase in cover (119 acres) though roughly 55 acres was attributed to mislabels. Mislabeling of this type was relatively common because its phenology while drying can be misinterpreted as annual grass. Further, it is difficult to know if the increased occurrence of *S. maritimus* resulted from actual invasions Although a perennial species, *S. maritimus* is highly managed making the timing of photography an important factor.

There was a net loss of 65 acres for *Salicornia* types (excluding *Salicornia/Atriplex* which accounted for 22 acres of mislabeled Tall Wetland Graminoids) with an average percent change of 0.0158%. Sixty-nine percent, or 45 acres, changed to *Scirpus maritimus* or to a *S. maritimus* type. Seventeen of the 65 acres were mislabels.

Also of note, *Lepidium latifolium* increased by 18 acres exclusively within managed wetlands; non-managed wetlands had no significant increase or decrease of *Lepidium* coverage. *Phragmites australis* increased in cover by 20 acres through expansion of existing stands and invasion of other vegetation types.

Construction activities resulted in significant changes within the Suisun Marsh study area. A warehouse was erected at Lake Herman Road and Industrial Way, converting 5 acres of annual grassland into a structure. In Cordelia, several oak trees were removed and 44 acres of annual grassland graded in preparation for development. On the Joice Island Unit of the Grizzly Island Wildlife Area, levee and ditch construction in Pond D divided 170 acres of wetland habitat dominated by *Salicornia virginica and Distichlis spicata*. Vegetative response is not yet detectable.

Given that it was possible to detect change in less than one percent of the vegetation for the Suisun Marsh study area, it is recommended that the change detection and map update process occur every three years with a contingency of more frequent updating for years with significant flood, fire, restoration or other event. Further, to ensure maximum utility from the change detection process, it is imperative that the aerial photography be of comparable quality and timing as the 1999 photo set.

The entire change detection process required approximately 320 person-hours by qualified personnel.

Conclusions

The Suisun marsh appears to be relatively stable between 1999 and 2000. Change was detected for 0.74% of the study area. Three-hundred-fifty-five acres, or 0.50%, of the mapped acreage was updated by correction of errors or more precise interpretation. The quality and timing of the aerial photography potentially limited the effectiveness of the chosen change detection methodology. The greatest cause for change (excluding probable misinterpretation) occurred as a result of human activities - clearing for development, and levee construction.

Literature Cited

Keeler-Wolf, T., M. Vaghti, and A. Kilgore. 2000. Vegetation Mapping of Suisun Marsh, Solano County – A Report to the California Department of Water Resources. Unpublished administrative report on file at Wildlife and Habitat Data Analysis Branch, California Department of Fish and Game, Sacramento.